

THE RECOGNITION OF BIOMEDICAL ENGINEERING WITHIN THE INTERNATIONAL COUNCIL FOR SCIENCE

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Abstract- Forty years separate the emergence of Biomedical Engineering in a meeting in Paris at UNESCO in 1959 from its recognition together with Medical Physics in 1999 by the International Council for Science. The main problems of definition and of identity of Biomedical Engineering as a scientific discipline are discussed and the different steps which have favoured this recognition are outlined

Keywords-IFMBE,IUPESM,ICSU

I. INTRODUCTION

No application of technology is more personal and life impacting than medical technology. As patients, we may have direct personal involvement, as potential beneficiaries we have a vested interest.

There is no unanimously accepted expression covering all the activities necessary for research, development, the applications and the use of medical technologies that extend the ability of health care (directly or indirectly) to improve or maintain patients' health. For research and development work, the term Biomedical Engineering is used. The application and use of medical equipment in clinical work is called Clinical Engineering. The activities to make equipment available and to maintain it is called Maintenance Bioengineering. As biomedical engineering research generates the modern health care technology necessary to save lives and alleviate suffering, the field of clinical engineering has emerged during the past 40 years to apply the knowledge obtained from this research. More recently the regulations and safety rules have induced the emergence of maintenance bioengineers.

No clear line of demarcation can be drawn between the duties of these different appellations. For sake of simplification, the name "Biomedical Engineering" will be used as a unifying expression.

II. IDENTITY OF BIOMEDICAL ENGINEERING

The identity of Biomedical Engineering is difficult to define for it is distinct from the traditional engineering disciplines in which it has its roots. Biomedical Engineering is a way of solving medical problems by combining the essential elements of engineering methodology and techniques with an understanding of anatomy, physiology and physiopathology.

The application of engineering methodology to medical problems is highly complex because it requires drawing on the experience of scientists and professionals from a wide range of disciplines. Biomedical Engineering involves forming this experience into a coherent engineering approach which addresses a specific medical problem.

A considerable amount of work has been done in biomedical engineering without the development of a rigorous definition on which it is founded. The experience of bioengineers has never or too rarely been formalized in a corporate understanding of fundamental principles. Medical and engineering disciplines and communities are too often considered as distinct and parallel. The synthesis of these two fields requires a permanent reappraisal because new engineering solutions emerge which are both more technically advanced and of increased relevance to the needs of the patients whom biomedical engineering exists to serve. A more philosophical approach is proposed by Max Valentinuzzi:

"Biomedical engineering has a unique, labile and sometimes elusive position in science and technology. As a rapidly evolving discipline, its definition still faces a certain degree of ambiguity. Even its name and possible divisions have not quite settled down yet. Neither new definitions nor terminology will be offered for there are more than enough for the time being. Rather the intent here is to place the discipline within the context of the paradigm concept."

Paradigm (etymology from Greek, para=alongside, deigma=pattern) is a word without a good clear-cut definition and means theoretical model of thought which orientates scientific research and reflection.

Max concludes *"A new frame of reference is added by bioengineering to the traditional frame (or paradigms) offered by biology, anatomy, physiology, pathology, pharmacology, biochemistry and all the medical empirical knowledge. Biomedical engineering can be taken as a paradigmatic shift that expands and complements, without negating the traditional medical paradigm"*.

III. RECOGNITION OF BIOMEDICAL ENGINEERING

Even if Biomedical Engineering is difficult (impossible ?) to define or to identify, its future lies in the recognition of an identity distinct from other branches of engineering. The long story of this recognition starts in the sixties with the

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foundation of the International Federation of Medical and Biological Engineering (IFMBE), grows with the association with the International Organization of Medical Physics to create the International Union for Physical and Engineering Sciences in Medicine (IUPESM) in 1980 and ends with this letter received in October 1999: *"For the record, I take great pleasure in informing you that the 26th General Assembly of ICSU (International Council for Science) held in Cairo, Egypt from 28-30 September 1999 voted to admit the International Union for Physical and Engineering Sciences in Medicine (IUPESM), already an International Scientific Associate of ICSU since 1982, as a Full Scientific Union Member. We are very pleased to welcome you more closely into the ICSU family."*

The different steps and milestones of this recognition are outlined in this presentation.

IV. IFMBE (<http://www.ifmbc.org/>)

In 1959 a group of medical engineers, physicists and physicians met at the 2nd International Conference of Medical and Biological Engineering, in the UNESCO building, Paris, France to create an organization entitled *International Federation for Medical Electronics and Biological Engineering*. Vladimir Zworykin was the Founder in 1959 and first President of the Federation. His dream was "to bring the movies in everybody's home electronically" and he invented the TV picture tube -the iconoscope- and among others the electron microscope. At that time, there were few national biomedical engineering societies and workers in the discipline joined as Associates of the Federation. Later, as national societies were formed, these societies became affiliates of the Federation.

In 1961, Zworykin as Conference chair for IFMBE and Herman Schwan as Program chair for IEEE organized at the Waldorf Astoria Hotel in New York the Fourth International conference on Medical Electronics in combination with the Annual Engineering in Medicine and Biology Conference: 2500 attendees from 20 countries, 300 papers, 70 exhibitions and simultaneous translations were provided in German, Russian, French and English.

In the mid-sixties, the name was shortened to *International Federation for Medical and Biological Engineering*. Its international conferences were held first on a yearly basis, then on a two-year basis and eventually on a three-year basis, to conform to the practice of most other international scientific bodies.

In June 2001, the Federation has an estimated 45,000 members in 43 affiliated organizations and 2 transnational affiliates: the Engineering in Medicine and Biology Society (EMBS) of the IEEE (<http://www.ieee.org/>) and the European Society for Engineering and Medicine (ESEM) (<http://www.esem.org/>).

Since 1970, the IFMBE logo has been used in more than 100 conferences, meetings or congresses in the frame of collaborations, sponsorships or affiliations. The mission of IFMBE is to encourage, support, represent and unify the Medical and Biological Engineering community worldwide in

order to promote health and quality of life through advancement of research, development, application and management of technology. One of its goals is the promotion of transnational collaborations in all appropriate educational, professional and ethical areas. Medical and Biological Engineering is in the midst of rapid changes with the emergence of new subdisciplines like cellular engineering, bioinformatics, nanotechnology in medicine, and telemedicine.

V. RECOGNITION OF BIOMEDICAL ENGINEERING THROUGH EDUCATION

In 1999 the Bologna Declaration on Harmonization in Higher Education was signed by 31 European governments. This declaration calls for the adoption of a system of easily readable and comparable higher education degrees in order to promote employability of European citizens and the international competitiveness of the European education system. The announced procedure for accreditation of educational courses will have major implications to the profession of Medical and Biological Engineering as to professional qualification, collaboration between healthcare providers, industry and universities, and the establishment of international research networks.

In December 2000, the Whitaker Foundation organized the Biomedical Engineering Educational Summit! The Whitaker Foundation is a private, nonprofit foundation that primarily supports research and education in biomedical engineering. The foundation's goal is to help establish biomedical engineering as a mainstream academic discipline at most major research universities. The foundation was established in 1975 and began its first biomedical engineering program in 1976, the Biomedical Engineering Research Grants Program. This program currently supports nearly 350 investigators at more than 160 institutions in the United States and Canada.

The purpose of the meeting was to help universities design and modify biomedical engineering programs to meet future needs. The summit was organized with the premise that biomedical engineering curricula should meet the guidelines previously formulated by the Whitaker Foundation Board. These include: a thorough understanding of the life sciences; mastering advanced engineering tools and approaches; making and interpreting quantitative measurements in living systems; using modeling techniques effectively and formulating and solving important medical problems, including designing devices, systems, and processes to improve human health.

To have a better vision of the way accomplished it is interesting to cite B.H. Brown:

"I became in 1960 the Executive Secretary of the Physiology Training Committee of NIH. Biomedical engineering did not exist. Fred Stone and I were interested in the possibilities of developing this new discipline, and within a few months of arriving at NIH, we organized a meeting of persons who might have an interest in the field. In December of 1961, a conference of 23 persons was held at NIH; with Otto Schmitt as chairman. I cannot remember all of the names, but those

of Herman Schwan , Otto Schmitt , John Jacobs , Art Guyton ,and Fred Grodins come to my mind

We argued for a day about what biomedical engineering was; what the components were, and how research and training should be organized? We reached no agreement at that meeting,or for many meetings over the following years.

In the beginning, we organized a combined training committee called Physiology and Biomedical Engineering. But this rapidly became a hot bed of argument.

Because of the differences, the joint committee did not succeed. The physiologists voted against all programs that did not include basic science as the fundamentals, and the engineers voted against all programs that did not have a firm foundation in engineering. Site visits became a source of debate as to whether programs should be in engineering schools or medical schools, whether and how much biology and engineering should be required, and if programs were "too basic" or "too applied " . '

VI. IUPESM (<http://www.iupesm.org/>)

The IFMBE achieved a close association with the *International Organization of Medical Physics*. (IOMP). The two international bodies established an *International Union for Physical and Engineering Sciences in Medicine* (IUPESM) founded in 1980. IUPESM comprises a global network of 60,000 graduate physical scientists and engineers in about 100 countries.

The major International Conference of the Union is titled the World Congress. The World Congress meetings of the Federation are combined with those of the International Organization for Medical Physics (IOMP) and co-ordinated by the Conference Co-ordinating Committee of IUPESM. The Congresses are scheduled on a three-year basis and aligned with the Federation's General Assembly meeting at which elections are held. The Millennium Congress was held in Chicago and the 2003 Congress will be in Sydney. (<http://www.eng.unsw.edu.au/wc2003/>).

IUPESM Key Programmes

Several key programmes have been established within IUPESM :

1) Public and Governmental Understanding of Science; International Policies for the Millennium. IUPESM can make a major contribution because the applications of science in health care and its immediate direct benefits are usually more readily understood and appreciated by the public and governments than many other scientific areas.

2) Education, Training and Continued Professional Development for the 21st Century with particular reference to Developing and Emerging Countries.

3) Global Biomedical Information Networking for Developing and Emerging Countries.

4) Evidence Based Health Technology. This programme is aimed at international assessment of the health benefits and cost-effectiveness of existing and new technologies in Health Care.

5) Medical Equipment Evaluation. The programme's aims are to establish and promote international protocols and standards

for Performance Testing, Quality Assurance, Safety and Environmental aspects.

VII. ICSU.INTERNATIONAL COUNCIL FOR SCIENCE

<http://www.icsu.org/>

ICSU is a non-governmental organization, founded in 1931 to bring together natural scientists in international scientific endeavor. It comprises 98 multi-disciplinary National Scientific Members (scientific research councils or science academies) and 26 international, single-discipline Scientific Unions (IUPESM is the 26th Scientific Union) to provide a wide spectrum of scientific expertise enabling members to address major international, interdisciplinary issues which none could handle alone. Scientific Union Members are international, non-governmental, professional organizations devoted to the promotion of activities in a particular area of science which have been in existence for at least six years. ICSU also has 28 Scientific Associates.

The ICSU Council seeks to break the barriers of specialization by initiating and coordinating major international interdisciplinary programmes and by creating interdisciplinary bodies which undertake activities and research programmes of interest to several members.

Interdisciplinary ICSU bodies are created by the General Assembly as the need for these arises in order to facilitate and coordinate interdisciplinary scientific and educational activities on an international basis. There are currently 18 such bodies. A number of bodies set up within ICSU also address matters of common concern to all scientists, such as capacity building in science, environment and development and the free conduct of science.

Joint Initiatives are international programmes organized by ICSU or its Members in partnership with other inter- or non-governmental organizations. Cooperation in such programmes is particularly close with various UN agencies, such as UNESCO, WHO, UNEP and FAO. At the present time, ICSU has 9 major joint initiatives in a variety of areas.

ICSU's objectives are set out in its Statutes and Rules of Procedure, to which all Members and Associates of ICSU adhere. One of the fundamental principles of ICSU is that of the universality of science (Statute 5), which affirms the right and freedom of scientists to associate in international scientific activity without regard to such factors as citizenship, religion, creed, political stance, ethnic origin, race, color, language, age or sex.

VIII. IUPESM FULL MEMBER OF ICSU

Having achieved the status of a Full member of ICSU, IUPESM is among the elite of International Unions and must be able to become an influential advocate globally for Medical Physics and Biomedical Engineering and to play a full part in establishing its own programmes and collaborating with other members of the ICSU family on projects of global significance.

IUPESM has participated within ICSU in the World Science Conference and has proposed collaboration with ICSU's

Committee on Science and Technology in Developing Countries (COSTED), the Programme on Capacity Building in Science (PCBS) and the International Network for the Availability of Scientific Publications (INASP).

The IUPESM Key programmes mentioned earlier are complementary to and symbiotic with those of ICSU. . IUPESM has created an ICSU Liaison Committee whose duties are to:

- build on established excellent relations with the ICSU Secretariat
- establish and maintain a good working knowledge of existing and proposed programmes within ICSU
- determine principal and secondary interests of other Unions and bodies within ICSU and generate a spirit of collaboration
- identify areas of potential future collaboration, especially global projects
- stimulate and consider programme proposals within IUPESM (IFMBE and IOMP) as candidates for grants either from ICSU itself or other international bodies, such as UNESCO, WHO, European Union, with the support (and stature) of ICSU
- formulate grant proposals and recommend priorities to IUPESM Council
- participate in ICSU Committees and activities
- contribute "populist" articles to ICSU's journal 'Science International' on various aspects of Medical Physics and Biomedical Engineering
- prepare proposals and contributions to be made at the ICSU General Assemblies.

X. THE FUTURE

We have to focus our activities in those directions that can provide maximum benefits and in which we can be most effective.

The status of Medical Physics and Medical and Biological Engineering at the national level does vary. In some countries we are members of our National Academies in some not. The National Academies which are ICSU members have quite an influence in science nationally and also internationally, not only through ICSU. For instance, in Europe the science and technology academies have formed an organization called Euro-CASE. There exists also an international forum for these academies. One of its meetings took place in France some months ago and one of its themes dealt with health technologies. Euro-CASE works closely with the EU Commission.

Therefore, the suggestion is that through IUPESM we should approach the National Academies that are ICSU members and seek their support that biomedical engineers and medical physicists should be eligible as members of the respective National Academies. The goal is to get our field recognized also at the national level.

One might also consider asking the National Academies to appoint liaison persons which whom IUPESM can establish and conduct a dialogue.

What about the future, including the prospective benefits of becoming a Full member of ICSU?

The future of IUPESM is dependent on the wholehearted support of the membership. The active involvement of many more members is essential for several reasons. First, not only is democracy improved but also a wider range of intellect, perceptions and new ideas should result. There are potentially exciting times and opportunities ahead for an invigorated IUPESM, which will demand greater and broader inputs. If IUPESM is to exploit its new potential, the workload is bound to increase and must be shared more widely.

X. CONCLUSION

The application of most facets of Physical and Engineering Sciences has been a "scientific wonderland" bringing enormous benefits for patients and people with disabilities, while taking meticulous care not to damage the ailing "human machine". Through research, development and scientific support, vital contributions have been made in most aspects of Health Care ,even greater advances can be expected in the next century.

It is essential that benefits and future advances are available equitably worldwide, especially in Developing and Emerging Countries.

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